U.S. Department of Energy

Tomorrow's Energy Today

for Cities and Counties

Cogeneration Powers Up Cost-Competitive Energy

Cogeneration offers local governments a flexible solution to reducing energy, operating, and maintenance costs for buildings in their districts.

Cities and counties build many multi-million dollar facilities, and supplying energy to run these facilities is a long-term obligation for a community. Cogeneration offers local governments an opportunity to reduce the cost of providing electricity, heating, and cooling to their buildings.

Cogeneration is the joint production and use of two or more forms of useful energy from one fuel-burning installation—for example, electricity, heat extracted from steam or hot water, and cooling (see illustration on p. 2). Cogeneration is appropriate wherever facilities with substantial energy requirements for both heat and electricity are located close to each other. As the distance between the cogeneration plant and the users of its thermal energy increases, so does the capital cost of the system.

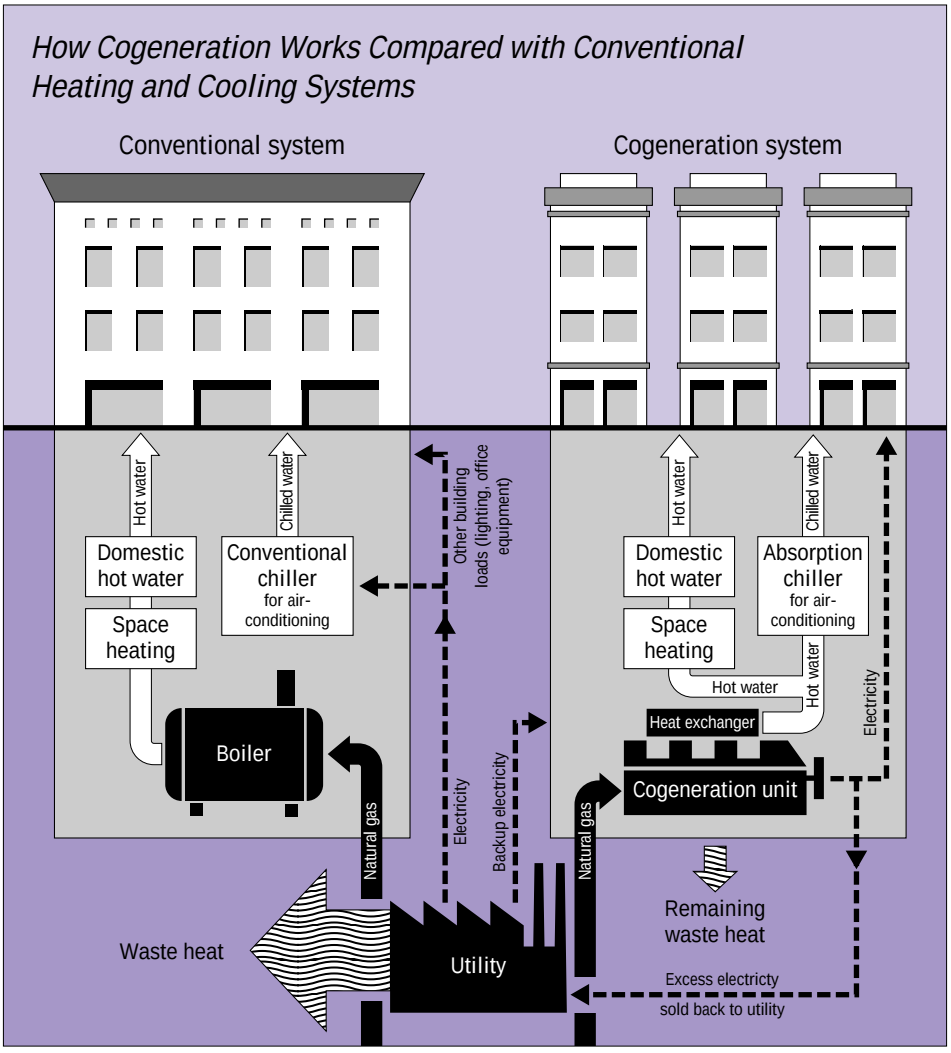
Sometimes cogeneration is combined with district heating and cooling systems. These systems produce thermal energy, which is used to generate

Trigen Energy Corporation / PIX2891

The new Mercer County Courthouse in Trenton, New Jersey, was designed to optimize the use of cogenerated heat. Because it is connected to a district heating and cooling system, the building doesn't have boilers, chillers, or cooling towers.

The Trenton, New Jersey cogeneration and district energy project reduces the amount of oil and gas consumed by nearly 50%.

electricity in a central plant. The waste heat from generating the electricity is distributed to buildings through a network of insulated pipes, providing space heating, domestic hot water, cooling from heat-activated chillers, or industrial process energy. The plant may also produce and distribute chilled water to air-conditioned buildings.The electricity generated is used on-site—often to operate chillers for space cooling—or fed back into the utility grid. This kind of cogeneration results in system efficiencies as high as 70%—about twice the efficiency of a conventional power plant that produces only electricity!



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Cogeneration on a Large Scale

Some local governments have made very effective use of cogeneration systems. For example, the city of Trenton, New Jersey, used a grant from the U.S. Department of Energy for a feasibility study of a cogeneration project. The study revealed the potential to save money by building a cogeneration plant. The city of Trenton contracted with Trigen Energy Corporation, a developer of district energy systems, to build and operate a plant, a very capital-intensive endeavor. By putting together this type of private-sector partnership to build and operate a cogeneration facility, cities and counties can avoid paying construction and maintenance costs.

The facility began operating in 1983 and provides heat to about 40 buildings in downtown Trenton. Since then, four new office buildings with 200,000 to 500,000 square feet (18,580 to 46,450 square meters), built without boilers, have been connected to the system.

The cogeneration plant has a buried heating loop, that is easily accessible and encourages commercial development by providing low-cost heat to housing, office buildings, a prison, hospitals, and industries in downtown Trenton.

The plant was sized so that its waste heat would meet the expected heating load. The electric output, which was seen as the "by-product," is purchased by the local utility. The 12-megawatt cogeneration plant burns either diesel (5% of the time) or natural gas (95% of the time). Trigen installed pollution controls to incinerate the by-products of the diesel fuel combustion (methane, carbon monoxide, and hydrocarbons) and reduce the nitrogen oxides by 30%.

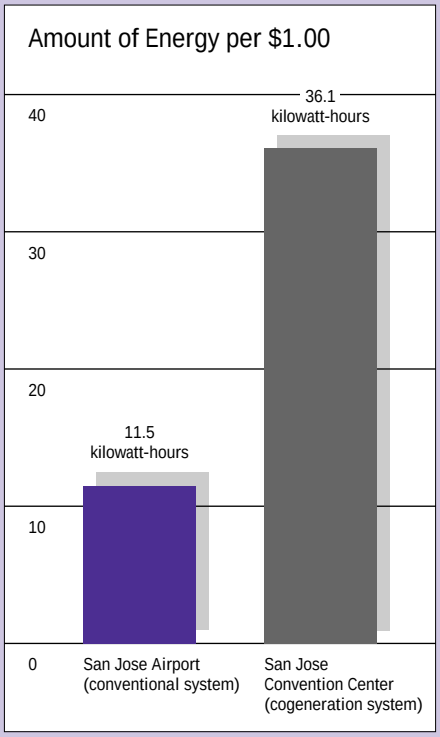
The result, as Alan Mallach tells it, has been very positive. "The cogeneration facility is an asset to the

An Energy Savings Comparison

San Jose city employees compared the energy use of the San Jose International Airport, which does not have a cogeneration system, with the San Jose Convention Center, because they are about the same size. The results illustrate the magnitude of energy savings possible from cogeneration.

The comparison shows that the airport gets 39,000 British thermal units (Btu) (11.5 kilowatt-hours) per dollar spent on energy, and the convention center gets 123,000 Btu (36.1 kilowatt-hours) per dollar spent. As Nayeem Sheikh, Facilities and Environmental Manager at the General Services Department in San Jose, explains, "Because of the efficiencies of the cogeneration system, the convention center is getting about three times more energy for its money than the airport is."

The economic performance of the cogeneration system has exceeded predictions. The facility uses one form of energy (natural gas) and produces three outputs (electricity, hot water, and chilled water). Sheikh adds, "It costs $48 an hour to operate and produces $190 worth of energy every hour ($150 worth of electricity and $40 worth of heat energy). Our cogeneration facility produces electricity at an average cost of $0.04/kWh compared to a direct purchase cost of $0.10/kWh from PG&E [Pacific Gas and Electric Company]."



"The cogeneration facility is an asset to the community. The city has realized some energy efficiencies and cost savings, and customers are satisfied with the service."

— Alan Mallach
Director of the Department of Housing and Development
Trenton, New Jersey

community," says Mallach, Director of the Department of Housing and Development for the city of Trenton. "The city has realized some energy efficiencies and cost savings, and customers are satisfied with the service."

Expanding the Trenton System

By 1985, Trigen managers saw an opportunity to improve the system by expanding to produce district cooling, says Donald Leibowitz. The facility was nearly at full capacity in the winter, but was wasting heat from electrical generation in the summer. According to Leibowitz, president of Trigen-Trenton District Energy Corporation, "We decided to enlarge to offer district cooling produced from waste heat."

This plan had a number of advantages. It improved the economics of the operation, eliminated the costs of operating and maintaining cooling equipment in each building, used cogeneration waste heat in the summer, in order to provide central air-conditioning for the legislative wing of the New Jersey State House.

To match the cooling loads of the buildings, which last only 10 hours a day, Trigen built a 3-million-gallon (11-million-liter) chilled-water storage tank. The tank helps the entire system operate more efficiently:

- The state's absorption chillers operate around the clock, using waste heat from the cogeneration system, which operates 24 hours a day.
- The chillers work at night to fill the tank with chilled water, which is distributed to customer buildings the next day.
- The system draws supplemental chilled water from the storage tank to be transported to most of the buildings on the chilled water loop during the day.
- The system's electric generators operate 24 hours a day.

The cooling system began operating in 1988, serving three state buildings with absorption chilling. The tank came on-line in 1989. The system currently serves 31 customer buildings.

The Trenton cogeneration and district energy project reduces the amount of oil and gas consumed by nearly 50%. Eliminating inefficient boiler systems in each building and using central boilers with higher annual efficiencies (more than 85%) also reduces air pollution. According to Trigen-Trenton, the district energy project allows the city to avoid the use of 4.6 million gallons (12.3 million liters) of fuel oil, thus avoiding 33,000 pounds (15,000 kilograms) a year of particulate emissions.

Cogeneration on a Small Scale

The city of San Jose, California, developed a smaller cogeneration project with equally positive results. As part of the city's Energy Management Program, the San Jose Convention Center's 1500-kilowatt cogeneration facility went on-line in June 1990. The facility supplies electricity, heat, and chilled water to the convention center and the adjacent main library, and heat and chilled water to the adjacent 350-room Hilton Hotel. These buildings occupy a total of about 1.5 million square feet (140,000 square meters). The cogeneration system consists of a single natural-gas-fueled reciprocating engine-generator, a 310-ton (281-metric-ton) absorption chiller, and a heat exchanger for heating water.

The project saves money and energy. On an annual basis, the cogeneration system saves approximately $480,000 in utility bills, compared to the previous heating, ventilating, and air-conditioning system. The facility operates 90% of the time during each 24-hour day.

The facility sells excess electricity to Pacific Gas and Electric Company (PG&E), the local utility, during off-peak hours, producing an additional revenue of about $34,400 annually in 1994. With this added income, the payback has been 2.5 years for the city, producing an attractive 40% return on investment.

The Hilton Hotel has also benefited from the project. The hotel saves $95,000 on energy bills each year and avoided spending about $400,000 to purchase major air-conditioning and heating equipment and build the space to house it.

A Versatile Technology

Trenton and San Jose illustrate just two possible cogeneration configurations. Cogeneration is a versatile, modular technology that saves money and energy in diverse applications. The Sacramento Municipal Utility District (SMUD), for example, began operating its first fuel-cell power plant in May 1994 at Kaiser Medical Center South. (A fuel cell is similar to a battery. When a fuel, such as natural gas or hydrogen, is added to the fuel cell, electricity and heat are generated.)

By converting natural gas directly into electricity, the 200-kilowatt plant emits virtually no pollutants. The fuel cell also meets half the medical center's hot water needs at half the previous cost.

Many sewer districts are also using cogeneration profitably. For example, the South Davis County Sewer Improvement District operates the North Plant Cogeneration Project north of Salt Lake City, Utah. The facility burns methane gas, a by-product of sewage sludge processing, both to generate electricity and to produce heat for the facility. The cogeneration system supplies about 75% of the facility's electricity and saves $5,000 per month on utility bills. ■

For More Information

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Mr. Mallach can provide information on the Trenton cogeneration project from the city's perspective.

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Mr. Leibowitz can provide information about the details of the Trenton cogeneration project from the perspective of a private partner.

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The city of San Jose offers free guidelines for developing a cogeneration project to public agencies and the private development community.

Cities and Counties on the Internet

Interested in more energy-saving ideas for your community? This fact sheet and others are available on-line. Go to the Energy Efficiency and Renewable Energy Network at: http://www.eren.doe.gov, find *Alphabetical Listing of all Sites*, and click on *Energy Solutions for Cities and Counties.*

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